FINAL REPORT

EVALUATION OF RECYCLED HOT MIX ASPHALT CONCRETE ON ROUTE 220

By

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ABSTRACT

This report describes the performance of an approximately 8-mi section of roadway on which the top two layers of asphalt concrete were milled, recycled through a conventional asphalt batch plant, and relaid. The recycled mix consisted of about 40% recycle material, 60% virgin aggregate, and 3.0% AC-5 asphalt cement. The project was accomplished with little difficulty and proved once again that recycling is an economical, feasible process. Over the 3 years the mix has been in service it has given very good performance and has provided impetus for the adoption in Virginia of a specification that allows a contractor to use as much as 25% recycle material in his hot mix production at his option.

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PROJECT DESCRIPTION

The asphaltic concrete pavement recycled was a 7.85-mi section of U. S. Route 220 in Franklin County, Virginia. The removal of 240 lb/yd^2 of material provided approximately 13,000 tons of recyclable material. This pavement was selected for recycling primarily because it was severely cracked through the surface and intermediate courses, but the underlying asphalt base course was in very good condition.

The installation report submitted on February 19, 1982, and approved February 26, 1982, describes in detail the old pavement, mix design, and recycle operation.(1)

Route 220 carries an ADT of about 6,400 vehicles in one direction, of which about 35% are trucks and buses. The 18-kip equivalent is estimated to be 638. The design thickness index of the pavement structure was 12.2. Deflection tests made by the Research Council indicated an average thickness index of 10.6, which is considerably less than the 15.5 required under the present traffic conditions. Therefore, instead of just replacing the 240 lb/yd^2 removed, 300 lb/yd^2 of recycled material was used to strengthen the pavement structure.

RECYCLING

The milling operation began in September 1981. In total, 110,528 yd^2 of the top 2 to 2 1/2 in of material were milled. The results of tests on the milled material were very similar to those obtained earlier from core samples and used for the preliminary design.

A bin and elevator were added to the plant to convey the recycle material to a 2 in scalping screen, and the material was then dropped into the #4 bin. The recycled mix used 40% recycle material, 36% #68 granite, 12% #8 granite, 12% sand, and 3% AC-5 asphalt cement.

PERFORMANCE

Although deflection tests made prior to rehabilitation of the pavement indicated that an overlay approximately 5 in thick was necessary to establish the strength required by the traffic analysis, and only 3 in of mix with recycled material were used, the project is performing very well. No cracking or distortions are evident after three years in service.

Tests were made on cores from the pavement and on asphalt from the cores as well as field tests over the three years of service. As the results shown later indicate, very little change has taken place in the project.

Lab Tests

Cores taken from several randomly selected locations on the project soon after construction and after approximately one, two, and three years gave the air void values shown in Table 1 and Figure 1.

Table 1

Air Voids, percent

	1981	1982	1983	1984
Average	4.9	3.1	2.6	2.1
Std. Dev.	1.5	1.0	0.7	1.2

Although the air voids have decreased steadily since construction, no distortion has taken place. The decrease in air voids of about 2% or 2.5% over the three years following construction is typical of many pavements.

The properties of the asphalt cement extracted from the cores taken each year are shown in Table 2.

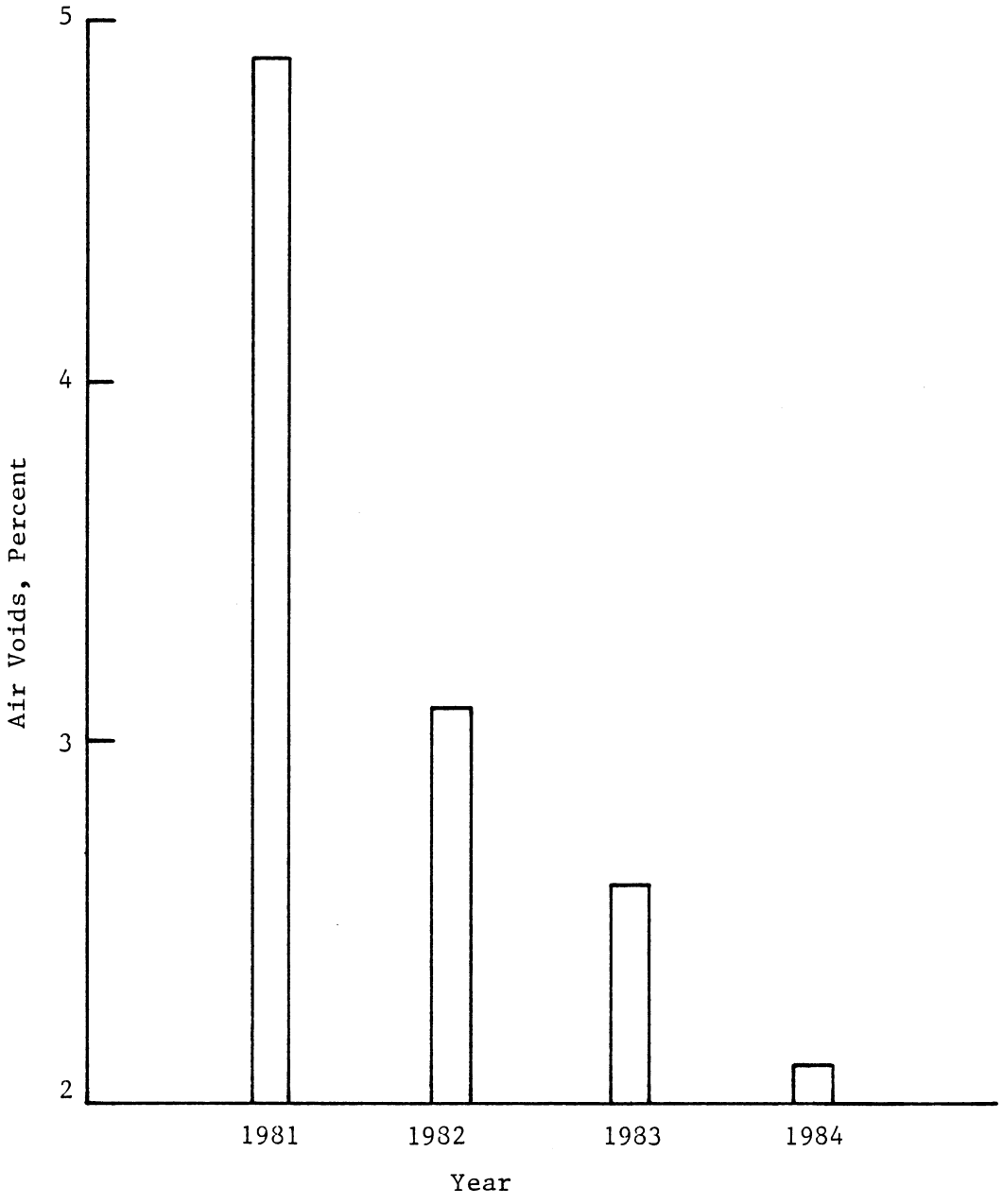

Figure 1. Decrease in percentage of air voids over time.

Table 2

Properties of Asphalt Cement

	1981	1982	1983	1984
Penetration, 77°F	46	47	49	44
Viscosity, 140°F, poises	5,550	5,214	5,216	5,525
Viscosity, 275°F, Cs	N.A.	584	600	605

The viscosity at 275°F was not obtained at the time of construction. The results in Table 2 indicate that essentially no change has taken place in the properties of the asphalt cement over three years. The variability of the results is typically within sampling and testing variability.

Field Tests

Three types of field tests have been run on the project. The first, roughness tests, were run with the May's meter and the results are shown in Table 3 and Figure 2.

Table 3

Roughness Results

	1981	1982	1983	1984
Roughness, in/mi				
Traffic Lane	83.2	87.7	90.3	92.4
Passing Lane	81.3	84.3	86.6	89.3
Equivalent Serviceability Ratings				
Traffic Lane	3.77	3.71	3.68	3.65
Passing Lane	3.80	3.76	3.72	3.69

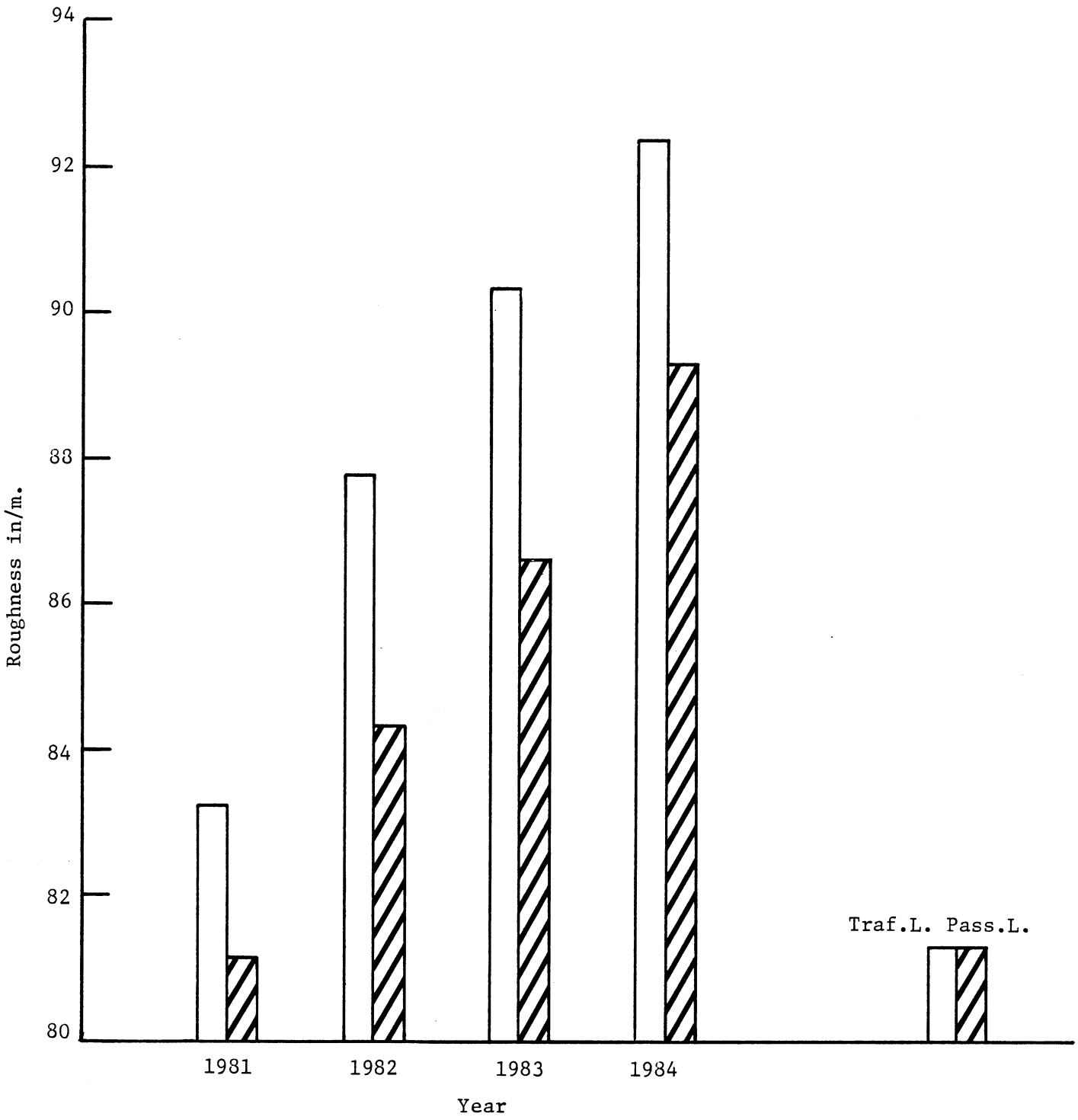

Figure 2. Pavement roughness as determined with Mays meter.

The results of the roughness tests alone are used to estimate the equivalent serviceability rating, since no cracking or distortion has taken place. The roughness has increased over the three years since construction, but is still well within tolerable limits. The rate of increase tends to be leveling off.

The second type field tests run were skid tests (SN 40 mph), and the results of these are shown in Table 4.

Table 4

Skid Resistance, SN

	1981	1982	1983	1984
Traffic Lane	39	42	46	39
Passing Lane	36	50	52	49

From Table 4, the results for tests made in the traffic lane during 1984 appear to be lower than those previously obtained, particularly the results from the 1983 tests in the same lane. However, no asphalt flushing has taken place and the results could reflect testing variability. But since some limestone aggregate was used in the recycle mix, it would seem prudent to continue skid tests over the next few years to determine if the decreasing trend continues. It should be mentioned that a value of 39 does not necessitate corrective action.

The third series of field tests performed on the pavement were deflection tests made with the Dynaflect, and the results of these are reported in Table 5.

Table 5

Deflection Tests

	1981	1982	1983	1984
Deflection, in	0.017	0.021	0.018	0.017
Bending Factor	66	65	67	67
Estimated Thickness Index	11.0	10.0	11.0	11.1

For this table, the deflections (maximum) have been converted to Benkleman beam values. The bending factor results allow an analysis of the deflection basin, and with the maximum deflections are used to estimate the thickness index.

The consistency of all the values reported in Table 5 indicates that the pavement structure is not deteriorating, even though the estimated thickness index is approximately 4 in less than that determined as necessary from an analysis of the 18-kip equivalency.

COSTS

As indicated in the installation report, the unit price for the recycled mix was $22.83/ton and that for planing was $0.82/yd^2. Converting the milling to a per ton cost gives a figure of $7.13/ton. Thus, the total cost of a ton of recycled mix was $29.96, which can be compared to a typical cost of approximately $28.00/ton for I-2 mix. The difference of approximately $2.00/ton appears justified in view of the project once again having demonstrated the practicality of recycling. As a spin-off from this project, a batch plant is now available to handle recycle mixes.

COLD MIX

With the recycle material left over from the Route 220 section, it was decided to add a CMS-2 emulsion and strengthen several sections of Route 40 in Franklin County. This approach was not satisfactory in that the paver could not produce an acceptable surface, and the remainder of the overlay work on Route 40 was done with hot recycle mix. The cold mix recycle section became so rough that it had to be overlaid in 1984, while the hot recycle sections are all performing well.

CONCLUSIONS

The 7.85-mi section of recycled mix is performing well after three years' service. The successful completion of this project, in addition to the two successfully completed earlier in the eastern part of the state, provided the impetus for Virginia to implement a specification for the use of recycle material. Although the use of 40% to 60% of recycle material has proven to be practical, to facilitate mix design and accommodate the use of the standard grade asphalt cement (AC-20) with recycle material, it was decided to limit the amount of recycle material

to 25% and to allow it to be used in any asphalt mix at the contractor's option. This special provision was implemented in 1984 and used by several contractors last year.

REFERENCE

1. Hughes, C. S., Installation Report, "Evaluation of Recycled Hot Mix Asphaltic Concrete on Route 220," VHTRC 82-R-38, February 1982.